Space Weather Technical Forecast

Issued on Sunday, 05 February 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1 peaking into the new week. Probable increase in X-ray flare activity through period from arriving regions.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity at GOES16 and 17 limited to occasional minor C-class flares. Some of these flares observed from sunspot region AR3207 in the southeastern quadrant, which remains as a diffuse Cri/Beta. This was one of four sunspot regions on the disc. The relatively new bipolar region in the southwest: AR3211 is classified as Bxo/Beta. All the remaining two regions AR3209 in the northeast and AR3210 in the southwest were otherwise unremarkable.
Although not registering as the peak flare of the period, also of note was a long-period C2.2 seen from the southeastern quadrant at 04/0053UTC, with this associated with a filament lift off. Coronagraphs indicate the ejecta as mainly orientated east of the Sun-Earth line. Another possible event of note was a filament channel-like signature on e.g. AIA304 in the northwest through the early hours (UTC) of Saturday 04 February. Coronagraph imagery is congested with many apparently peripheral emissions. At present there are no significant Earth-directed CMEs from available imagery, however some CME effects may reach Earth from Day 3 (7 Feb).

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by DSCOVR and ACE at L1, were indicative of slow-ambient solar winds declining from 350 to 320km/s. The solar wind density was mostly near average between 5 and 10ppcc. The IMF was Weak throughout while the north-south component, Bz, was also at weak levels between +/-6nT. The phi angle was mostly negative (towards the Sun). The net effect of the above solar wind measures was for Quiet to Unsettled geomagnetic activity (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at Background levels throughout.
High energy electron flux (greater than 2MeV) measured by GOES16 was predominantly at Normal Background levels. The associated 24-hour electron fluence generally declined with 1.19e6 integrated pfu observed at 05/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low solar activity is expected. There are signs that the arriving eastern limb contains more potent active regions (from CME evidence, prominences and STEREO A EUVI 195 imagery), with a probable increase in activity therefore considered through the coming UTC working week. This being said, until any regions show, the current Slight Chance of M-class activity is held constant given the largely quiet current Earth-facing side.

Solar Wind / Geomagnetic Activity: No significant CMEs feature in the forecast at present, with any activity most likely from Day 3 (7 Feb)...Solar winds starting at slow-ambient levels. Uncertainty surrounds the arrival (and now polarity) of the fast wind from CH74 leads to reduced

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confidence for much of the remainder of the period, although STEREO A implies any fast wind is at least a day away. Slightly Elevated to Elevated solar winds are most likely from this feature, with arrival possible from later Day 1 (5 Feb). Geomagnetic activity is expected to be Quiet to Unsettled with the greatest Chance of a Minor Storm (G1) interval from Day 3 (7 Feb), from the arrival of any anticipated CME activity.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is expected to remain at Background levels throughout given the dearth of current sunspot groups.
Electron flux is expected to remain largely at Background to Moderate levels. Electron fluence is expected to remain well below the Active (1e8 integrated pfu) threshold. Any increase in electron populations is most likely towards the end of the forecast period in the wake of the peak of any fast wind, however this is complicated by any potential increase in geomagnetic activity by that time.

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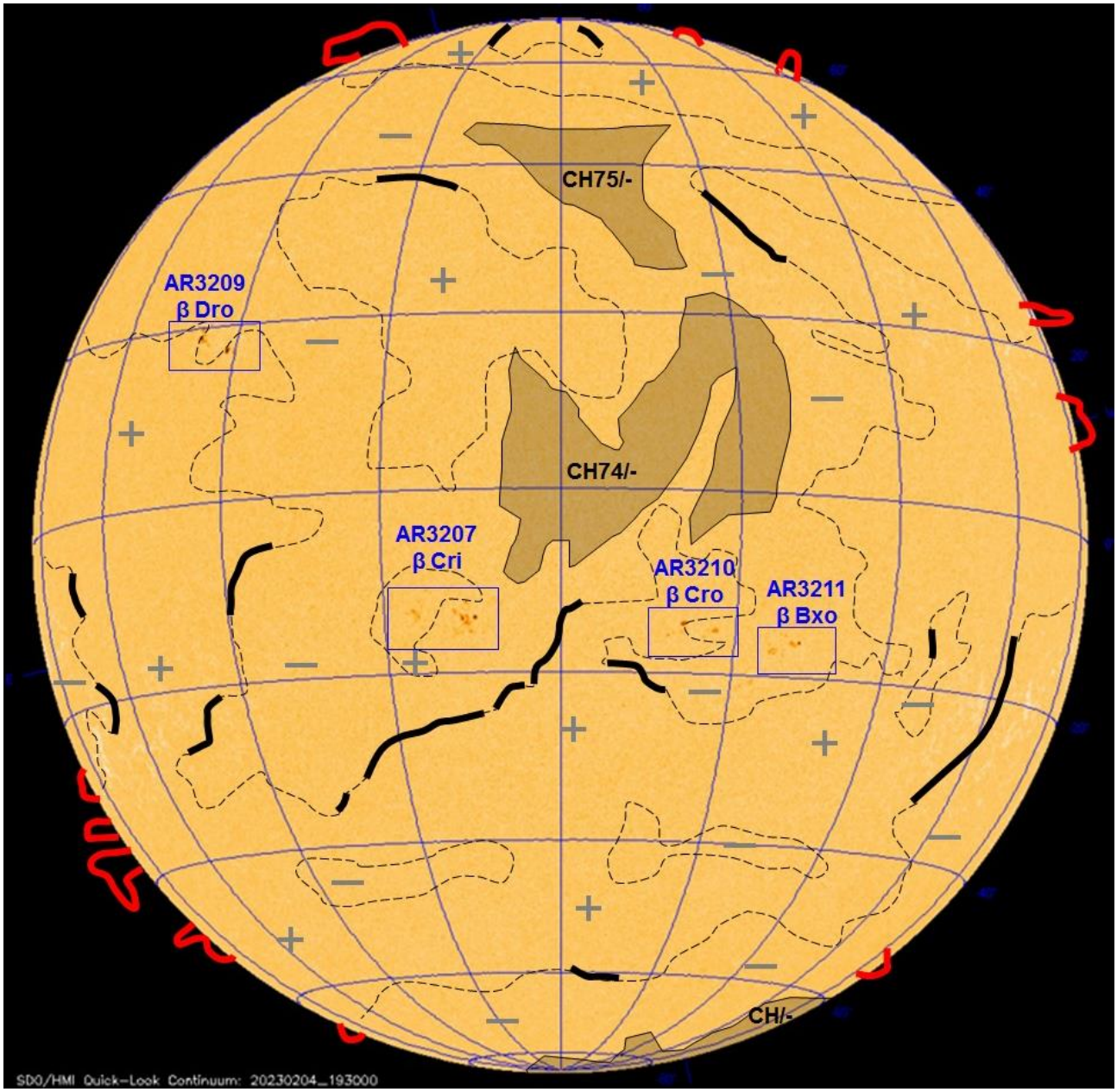
Figure 1. Solar Analysis Valid 2000UTC, 4 February 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

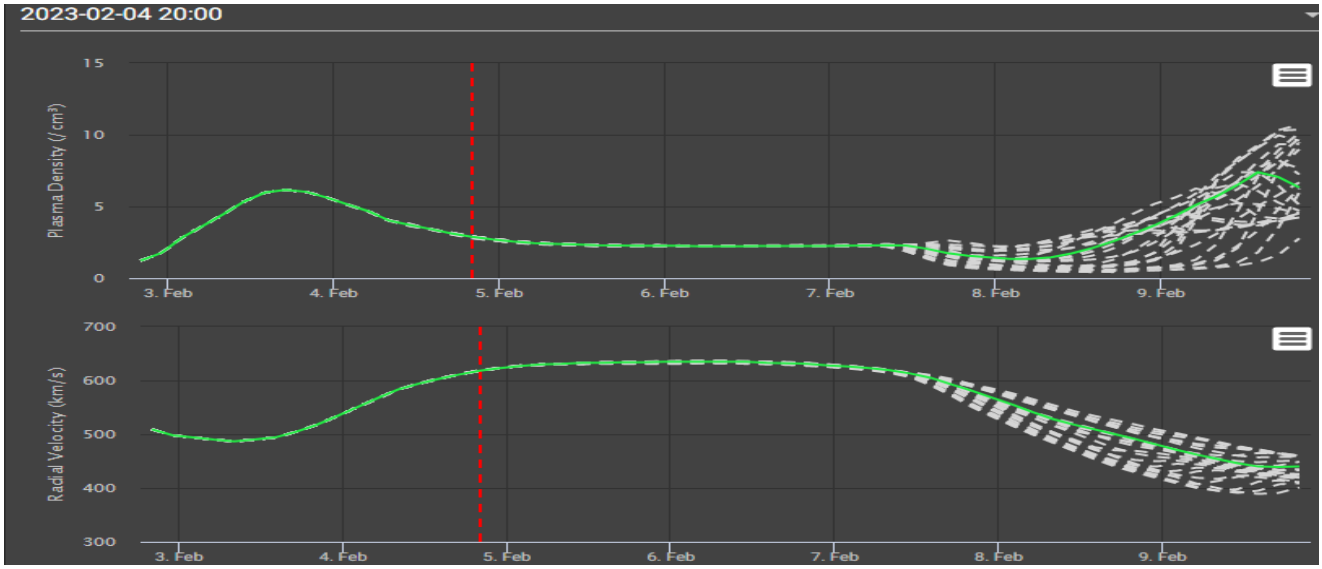
The current geomagnetic forecast comprises the anticipated coronal hole high speed stream from non-persistent CH74 which is analysed with a negative polarity, however this seems to be less clear-cut now it is crossing the meridian, as it occupies a large and magnetically diffuse region on HMIBC imagery, as well as having an ambiguous extent in AIA193 and 211. Should it be a negative coronal hole, this would be relatively more impactful as we near the vernal equinox. Of greater confidence is the fact that there does not seem to be any evidence of any fast wind regime in currently available STEREO A MAG and PLASTIC data, which implies that any fast wind feature is at least a day away from affecting Earth. MOSWOC Enlil model output is currently significantly wayward in forecasting a Strong solar wind of 600-650km/s at Earth and is probably around 24 hours ahead of any fast wind arrival given available STEREO A evidence. All considered, a peak Chance of G1 is considered from Day 3 (7 Feb), albeit with greater than average uncertainty. The next couple of days probably seeing generally Quiet to Unsettled geomagnetic conditions.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	15	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil confirmed, lower than average confidence.

Figure 2: Met Office CME ensemble output indicating potential arrival times from 7 Feb. onwards.



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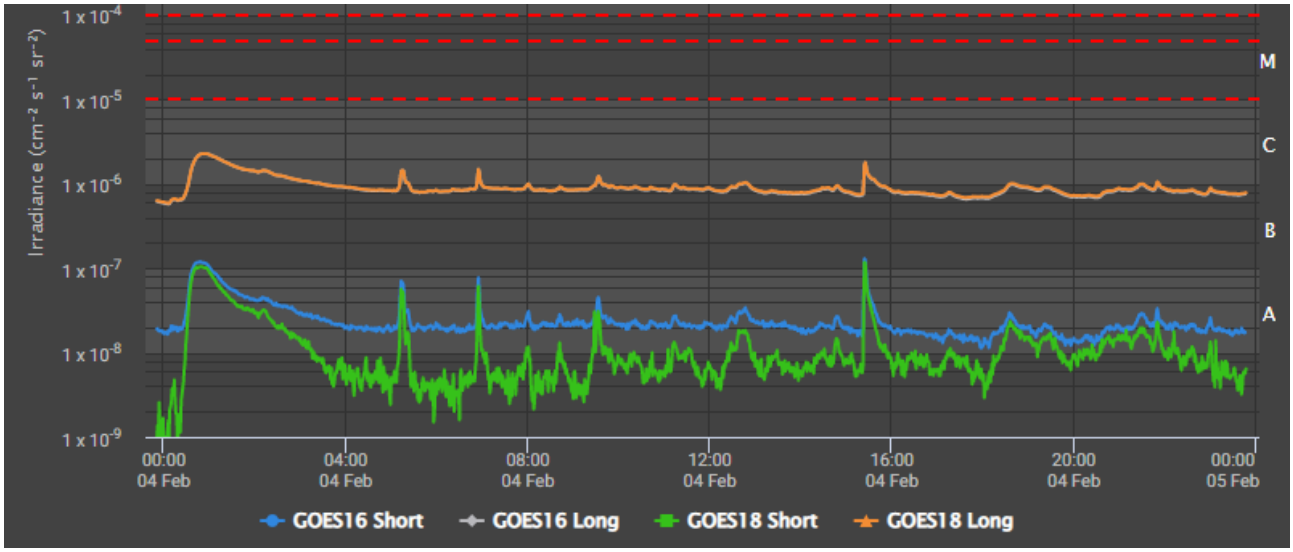
Radio Blackouts - X-Ray Flares:
The current solar disc is the preserve of relatively few and simple bipolar sunspot groups, with two recently fading to plage, and Low solar activity is therefore most likely. Of potentially greater interest is the potential arrival of numerous Carrington locations for spot groups over the eastern limb. In numerical order Ex-AR3286; 3288; 3290; 3291; 3292; 3294 and 3295 are all due. Adding to this evidence is STEREO A EUVI195 imagery, which suggests a southern solar hemisphere bright flux region (perhaps newly-developed), as well as far-side helioseismography, which shows an eastern hemisphere bias of signals from the far side, implying the new arrivals will probably be more significant than the week after (mid-month). Also of note is the presence of a large northeastern solar limb prominence and some recent limb-based CME activity from this area. All the above is borne in mind, however the current far side and directly observable sunspot groups are relatively quiet and unremarkable, resulting in a current daily Slight Chance of M-class flares, with this risk held throughout with a view to react upwards into the coming new week

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	10	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES x-ray flux showing several low levels C-class flares over the preceding 24 hour period.



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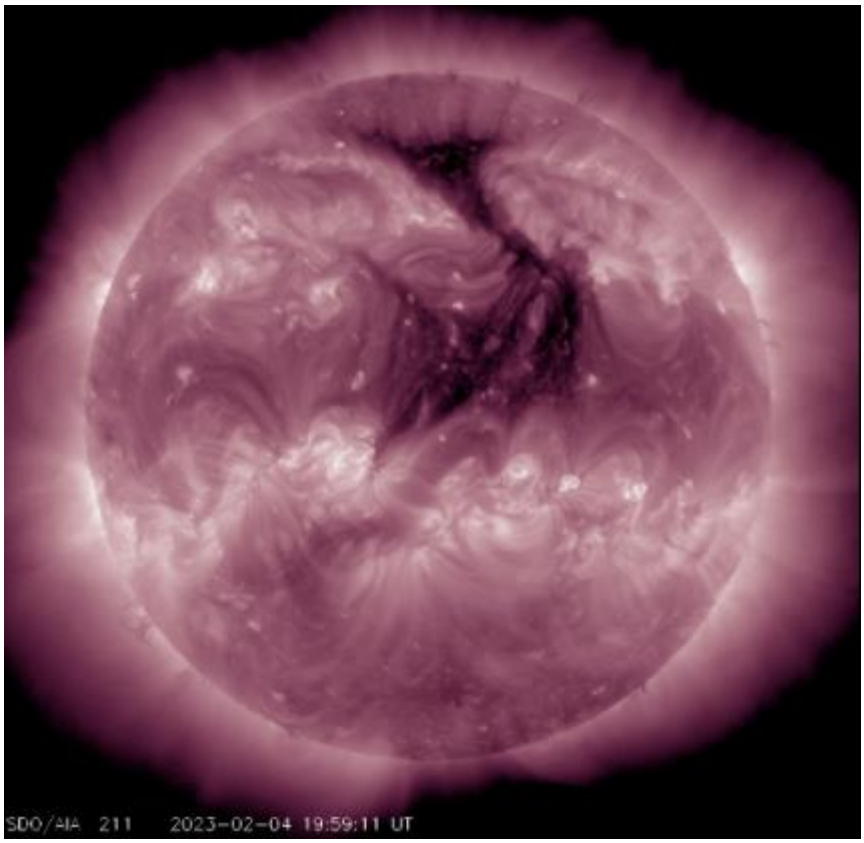
Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux as observed by GOES16 is at Background levels, and is currently expected to remain as such throughout the period given the absence of significant sunspot groups.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO-aia 211 imagery showing probable location of the coronal holes facing Earth.



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at Normal Background levels, and is expected to remain so in the near-term due to the lack of suitable external influence. Beyond the current UTC weekend, MOSWOC REFM is rendered less useful for this forecast period given the initial vestigial CME influence and then the reliance of the forecast on a non-persistent fast wind, where even the polarity of the driving feature now appears less clear-cut.

Overall, uncertainty in the geomagnetic forecast carries over into the electron outlook, with the chances of exceeding Active 24-hour fluence considered unlikely during this guidance period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output showing little expected activity.

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